Crystal Growth and Property Tuning of Topological Quantum materials

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Background/Relevance

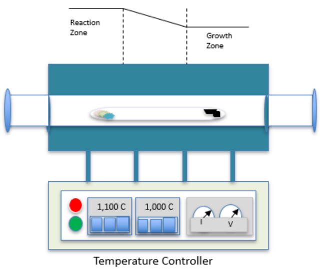
- Moore's law became challenging below 10nm due to emerging quantum effects.
- Topological quantum materials with exotic properties are promising for electronic, optoelectronic, and spintronic devices.

Innovation

- Observe the symmetry-protected electronic states of in Dirac nodal-line semimetal of ZrSiS-family.
- Tuning the exotic properties of the materials.

Approach

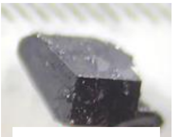
- Grow single crystals using chemical vapor transport and flux methods.
- Structural and elemental characterization using x-ray diffraction (XRD) and energy dispersive spectroscopy (EDS).
- Characterize the electronic properties of the topological Dirac fermions in single crystal.
- Tune the lattice and composition of the material; characterize the evolution of the Dirac states using resistivity, Hall effect, and quantum oscillation measurements.



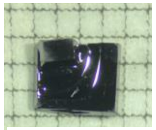
Schematic of CVT growth

Key Results

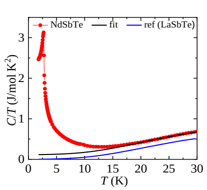
- Successful growth of ZrXY (X=Si, Ge; Y=S, Se Te), *Ln*SbTe (*Ln*=La, Ce, Gd, Sm, Pr, Nd) single crystals using chemical vapor transport and flux method.
- Magnetization, Heat capacity measurement shows the AFM ground state with enhanced electronic correlation in NdSbTe and SmSbTe.
- Collaborative ARPES study shows the topological Dirac States in SmSbTe.

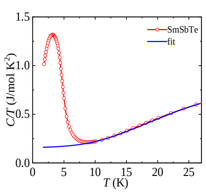


NdSbTe



SmSbTe





Conclusions

- Single crystals of Dirac nodal-line semimetal are synthesized by chemical vapor transport and flux method.
- SmSbTe, NdSbTe materials are antiferromagnetic and PrSbTe and LaSbTe does not have magnetic transition till 2K.

Future Work

- Tune the properties of ZrXY and *Ln*SbTe using magnetic field and strain.
- Characterize the evolution of the Dirac states using resistivity, Hall effect, and quantum oscillation measurements.
- Extend area of research to the other materials showing similar properties.

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